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SOME CHARACTERISTICS OF THE FISH FAUNA OF A DAM IN THE LAKE VICTORIA REGION OF TANZANIA INCLUDING THE EFFECTS OF MULTISPECIFIC STOCKING WITH *TILAPIA* SPECIES

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ABSTRACT
Malya dam had been stocked with several species of *Tilapia*. However, all but the species endemic to the region, *T. esculenta*, made only marginal contributions to the fishery. *T. zillii* particularly had failed to establish itself, probably because its niche had been previously filled by *T. rendalli*. Planktivorous *Tilapia* species predominate in Malya dam but in smaller dams in the region herbivorous *Tilapia* are relatively more abundant. Six non-cichlid species and one of *Haplochromis* were found in the dam.

Tilapia esculenta, the most economically important species, was estimated to grow to within 9-10 cm first year and 16-18 cm second year. The largest specimen caught was 30.5 cm, and the smallest mature individual 19 cm. The fish of the dam grew more slowly and matured at a smaller size than those of the same species in Lake Victoria. The biological pattern of *T. esculenta* in Malya dam was similar to that of this species in Lake Victoria.

INTRODUCTION

Malya dam, which is one of the largest dams in the Lake Victoria region of Tanzania, was completed in 1947. Since that time a stocking programme using several species of *Tilapia* has been carried out and a fishery has developed in the dam. The present survey was carried out to assess the general situation which had developed in the dam with respect to the fish and fishery up to 1968, the time at which the survey took place. Particular attention was paid however to the effect of the stocking programme and to the biology of the most economically important species in the dam, *Tilapia esculenta* Graham. Stocking newly created stretches of water, or even established waters, with *Tilapia* or other types of fish is common practice in Africa and so guidelines to a rational approach to this procedure are necessary. A knowledge of the biology of *T. esculenta* is useful as this species is important in many minor waters which support fisheries in the Lake Victoria region. The fisheries on such waters may be relatively small but their importance lies in the fact that dams are usually built in areas where other water is scarce and consequently where fresh fish is otherwise unavailable. For example, even Malya village, the site of the present work, which is only 75 miles by road from Lake Victoria, received only semi-smoked fish from this major source.

THE SITE

Malya dam has an average surface area of 70 ha. At deepest, close to the centre of the dam wall, it is 9.4 m deep just after the rains. The water is fringed with papyrus beds particularly dense at the tail of the dam, and during the rainy season water from the dam floods some of the surrounding grassland, forming a seasonal swamp. There are no rivers running into the dam, the water being an accumulated run-off from the land.

The rainfall in the area occurs mainly between November and April with most rain falling between January and April.

The dam lies at latitude 3° S and is 48.5 km from the nearest point of Lake Victoria. It was completed in 1947 and since that time had been stocked, firstly with *Tilapia macrochir* Boulenger and *T. rendalli* (Boulenger) previously called *Tilapia melanopleura* but in fact not the true *T. melanopleura* (see THYS VAN DEN AUDENAERD 1964), and later with *T. zillii* (Gervais).

Some limnological features of the dam are given in Table 1 and the methods of analysis were the same as those outlined in a previous paper (PAYNE 1971). The concentration of nitrate and phosphate appears to be rather low, as has been found in several other Tanzanian dams (BAILEY 1966).

The early morning surface temperatures of the dam from March to July ranged from 20.6° C to 22.9° C.

THE FISHES OF MALYA DAM

Species Present in the Dam

The dam was sampled using a fleet of nylon gill nets of $1\frac{3}{4}$ in, 2 in, $2\frac{1}{2}$ in, 3 in, $3\frac{1}{2}$ in, and $4\frac{1}{2}$ in mesh sizes on fifteen occasions between March and July. The fleet was left down from 5 p.m. until 8 a.m. on each occasion. The total number of each species caught for each mesh size is given in Table 2.

Since 1947 a wide range of species has become established in this comparatively small stretch of water. *T. macrochir* and *T. rendalli* were both introduced into the dam in the mid-1950s and *T. zillii* was introduced in three batches of 1,000 fish each in the late 1950s. This last species has

Table 1. Results of chemical analysis of water from Malya dam

Determination	(3/12/67)	(15/4/68)
pH	7.6	7.7
Total Alkalinity (ppm $CaCo_3$)	35	30.5
Nitrate (ppm)	0.15	0.14
Phosphate (ppm)	—	trace
Iron ($Fe^{2}+$ and $Fe^{3}+$), (ppm)	0.12	nil
Oxygen—surface		
22/6/68 morning > mg/ltr	5.67	
22/6/68 morning > % saturation*	93.8	
22/6/68 evening > mg/ltr	5.89	
22/6/68 evening > % saturation*	85.7	
5/7/68 morning > mg/ltr	6.00	
5/7/68 morning > % saturation*	94.4	
Oxygen—4.7m depth (deepest point)	nil	

*% saturation corrected for the effects of temperature and altitude on the solubility of oxygen by employing the factors suggested by GOLTERMAN (1969).

Table 2. Results of fishing, March-July at Malya dam

Mesh Size (in)	*Marcusenius victoriae**	*Labeo victorianus*	*Schilbe mystus*	*Clarias mossambicus*	*Protopterus aethiopicus*	*Haplochromis sp.*	*Tilapia esculenta*	*Tilapia macrochir*	*Tilapia rendalli*	*Synodontis victoriae*
$1\frac{3}{4}$	32	20	8	6		11	50		2	1
2	1	39	5	7		5	96	7	2	
$2\frac{1}{2}$		1	2	5	1	2	119	2	5	
3			1	5	3		51		3	
$3\frac{1}{2}$			1	5	8		33		1	
$4\frac{1}{2}$				1			1			

*(Gnathonemus victoriae)

Table 3. Food and feeding habits of naturally occurring species in Malya dam

Species	Food & Feeding Habits	Author
Marcusenius victoriae	Insectivorous, particularly chironomids also small arthropods. Frequents marginal papyrus swamp, (noted in Malya dam).	CORBET 1961
Labea victorianus	Epilithic and epiphytic algae.	,,
Schilbe mystus	Piscivorous, particularly *Haplochromis;* also insectivorous largely taking surface types. Probably a tendency to feed in upper layers of water.	,,
Clarias mossambicus	Piscivorous, largely *Haplochromis* but adaptable and will take a wide range of animal types.	,,
Synodontis victoriae	Molluscs, mainly gastropods, and insects particularly chironomids.	,,
Protopterus aethiopicus	When less than 35cm mainly insectivorous, above this feeds on molluscs particularly gastropods.	,,
Haplochromis sp.	Insects and fish fry.	
Tilapia esculenta	Planktivorous, largely diatoms.	FISH 1955

apparently completely failed to establish itself in the dam. *T. esculenta* may have arrived naturally as there is no record of it being stocked artificially. The source of the remaining species is presumably Lake Victoria.

A species which becomes established in Malya dam must have come to terms completely with the lacustrine environment in terms of feeding and reproduction. The reproductive behaviour of cichlids in general seems to be effective in both riverine and lacustrine environments (LOWE-McCONNELL 1959) and their feeding habits are also apparently quite plastic, consequently cichlids have radiated extensively in lakes (LOWE-McCONNELL 1969). It is therefore no surprise to find cichlids relatively abundaut in Malya dam.

The majority of non-cichlids in Lake Victoria spend some part of their time for breeding or feeding purposes in rivers (CORBET 1961). Only those species which can completely eliminate the riverine phase from their life cycle could become established in Malya dam, for example, *Labeo victorianus* Boulenger and *Schilbe mystus* (Linn.) normally enter rivers extensively to breed although they actually lay their eggs in floodwater pools (WHITEHEAD 1959). In Malya dam therefore they presumably substitute a lateral migration when the rains cause the dam to flood the surrounding vegetation and lay their eggs in these flood-water areas.

No detailed analysis of the food of the fishes in the dam was attempted, but drawing upon the work of other authors, particularly the detailed study of CORBET (1961), it is possible to outline the main feeding niches occupied by the different species as shown in Table 3. From this point of view the collection of species in Malya dam appears to be quite closely integrated, each specie occupying a more or less well-defined niche with little overlap between them. The lack of overlap in niches is in contrast to other tropical aquatic habitats, particularly the larger lakes, rivers and streams, where there can be much overlap of feeding habits (LOWE-McCONNELL 1969). The dam, in fact, is much more recent than any of these other habitats and may be regarded as an "initial" community (MARGALEF 1959) where competition for nutritional resources is the main factor in determining the species composition. On the other hand it is possible that other species from Lake Victoria would be capable of finding a niche in Malya dam, and that the main determining factors are not competition for food but quirks of the dispersal mechanisms. For example, a species of *Barbus* was found in another dam 30 km away.

A notable absentee from Malya dam is

Table 4. Proportions of various *Tilapia* species caught in dams of different areas

Dam	Area (Ha)	Total Number	Planktivore / brooders				Leaf chopper / guarders		
			T. esculenta %	*T. macrochir* %	*T. leucosticta* %	Total %	*T. rendalli* %	*T. zillii* %	Total %
Malya	70	372	94	2.5	—	96.5	3.5	—	3.5
Nyalikungu	7.4	92	63	29	—	92.0	8	—	8.0
Rulenge	0.8	12	—	—	42	42.0	—	58	58.0

Tilapia variabilis Boulenger, although like *T. esculenta* it is endemic in Lake Victoria. It was not found in nearby dams, nor has it been recorded currently by Fishery Assistants in the district. It has been reported previously however (BAILEY 1966).

Relative Abundance of Tilapia Species

The genus *Tilapia* can be divided into two groups which have fundamentally different habits. The first group, exemplified in the present case by *T. zillii* and *T. rendalli*, feed primarily by chewing macrophytic plants and hence may be called "leaf choppers" (FRYER and ILES 1972). In addition, fish of this group build a nest and often remain close to this whilst guarding both eggs and young during development (LOWE-McCONNELL 1959). Fish of the second group, for which a separate generic status under the name *Sarotherodon* has been suggested (TREWAVAS 1973), tend to be algal feeders utilizing either phytoplankton or benthic algae often depending upon which is the most readily available. During reproduction the eggs and young of these fish tend to be brooded in the mouth of one of the parents for much of the developmental period. The ability of this second type of *Tilapia* to feed on phytoplankton and also, to some extent, the habit of brooding the young, enables these fish to exploit open areas of water whilst *Tilapia* of the first type must remain for the most part in shallow water amongst or close to the rooted vegetation necessary for food and shelter (LOWE-McCONNELL 1959). With respect to dams, these differences between *Tilapia* species raise the possibility that the size of the dam may effect the relative sizes of the niches available to the two types of *Tilapia*. Thus, the larger the dam the larger the area of open water available compared with the fringing vegetation and consequently the larger the niche available to fish capable of exploiting open water conditions in relation to that of species more or less restricted to the vegetation of the dam edge.

Table 4 shows the results of samples of three dams of different in sizes in the Lake Victoria region. For Rulenge dam only a 3 in mesh net was available, which accounts for the small numbers caught. Observation of the fish in the dam suggested that the relative proportion of *T. zillii* to *T. leucosticta* Trewavas indicated by the sample was not unduly biased.

In these three dams at least, there is an inverse relationship between size of dam and the relative abundance of leaf chopper/guarders to planktivore/brooders.

In Malya dam the niche of the leaf chopper/guarder type is occupied by *T. rendalli*. During sampling in this dam no *T. zillii* were caught, yet some 3,000 fry had been introduced some years previously. *T. rendalli* and *T. zillii* have very similar feeding and reproductive habits. Competition between them stocked together in ponds has been noted as leading to the elimination of *T. rendalli* by *T. zillii* (KIENER and LAMARQUE 1969; GOSSE 1963), although, judging from the account of Gosse, *T. rendalli* is dominant in at least some of the natural biotopes in the area he studied. In Malya dam, where *T. rendalli* was introduced first, the niche for macrophyte-feeding, nest-guarding *Tilapia* was apparently filled by the time *T. zillii* was introduced and hence this species failed to establish itself.

THE GROWTH AND BIOLOGY OF *T. ESCULENTA* IN MALYA DAM

T. esculenta is economically the most important fish in Malya dam supporting a fishery of some three or four canoes. The fish are caught by the use of 3 in mesh gill nets.

During March, June and July samples of *T. esculenta* were taken using the gear and method described in the previous section. The numbers caught in nets of different mesh

Table 5. Numbers of *T. esculenta* caught in a fleet of gill nets during the months of the survey at Malya dam.

Month	$1\frac{3}{4}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	$4\frac{1}{2}$	Total	Number of samples	Catch per samples
	Mesh sizes (in)								
March	35	38	33	18	13	0	137	4	34.2
June	13	50	62	22	11	0	158	5	31.6
July	2	8	24	11	9	1	55	6	9.2
Total	50	96	119	51	33	1	350		

Table 6. Changes in the catch frequency for *T. esculenta* of different mesh size gill nets between March and June in Malya dam.

	Mesh size (in)					
Month	$1\frac{3}{4}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	Total
March	35	38	33	18	13	137
June	11.27	43.35	53.75	19.07	9.54	136.98
Change from March to June/as % March totals	−68	+14	+63	+6	−3	

sizes during these periods are shown in Table 5.

In Table 6, the numbers caught in March and June have been made directly comparable and the change in numbers caught at each mesh size has been expressed as a percentage of the March totals.

Between March and June there were relatively large changes in the number of individuals caught in both the $1\frac{3}{4}$ in mesh net (by $P<0.001$) and the $2\frac{1}{2}$ in mesh ($P<0.05$). The decrease in number caught in the $1\frac{3}{4}$ in net amounted to 68% whilst the increase in the $2\frac{1}{2}$ in net was 63% of the March total. By assuming that these changes are brought about by growth and consequent recruitment of fishes from a section of the population sampled by a net of one mesh size to a section sampled by a larger mesh, an estimate of growth can be obtained.

The selection characteristics of nylon gill nets for *T. esculenta* follow an approximately normal distribution (GARROD 1961). The population is therefore sampled progressively less well towards the extreme sizes caught in a net of any one mesh size. Assuming that the normal distribution found by GARROD (*loc. cit.*) holds here, the sample characteristics for each net are given in Table 7.

Table 7. Selection characteristics of gill nets for *T. esculenta* assuming sample approximates a normal distribution

Mesh Size (in)	n	Mean L(cm)	σ	95% limits($\pm$)
$1\frac{3}{4}$	38	12.05	1.095	2.15
2	77	13.85	0.994	1.95
$2\frac{1}{2}$	92	16.7	0.920	1.80
3	44	19.3	0.610	1.20

n = number used in calculation.
Mean L = mean length.

Between March and June there was a drop of 68% in number caught in the $1\frac{3}{4}$ in net. If recruitment into the $1\frac{3}{4}$ in net was negligible then the mean length of the remaining 32% in June would approximate the mean size taken by the net and the mean size of that 32% would have lain at 16%

of the area under the curve in March. Thus the original section of the population sampled must have grown to the equivalent of an increase from the 16% mark of the normal curve up to the mean, i.e. $12.05-10.51=1.54$ cm.

That the recruitment into the $1\frac{3}{4}$ in net sample is small can be seen from the large reduction in relative numbers caught in this net in July (Table 5) compared with June. Evidence will also be presented below that this is, in fact, the result of spawning peak from a well-defined breeding reason.

As the fish originally sampled in the $1\frac{3}{4}$ in net are growing at some 1.54 cm/2 months so that 68% grow beyond the range of this net, then the number coming within the range of the 2 in net must increase. This increase can be estimated by plotting the curves for each net to determine the point of intersection; the area of overlap can then be calculated. By advancing the mean of the $1\frac{3}{4}$ in net sample 1.54 cm and repeating the above procedure, the increase in area of overlap can be calculated. Thus the effect of the section of the population sampled by the $1\frac{3}{4}$ in net growing at 1.54 cm/2 months would be to increase the numbers available to the 2 in net of 49.7%. This of course ignores the region poorly sampled lying between the two curves but in fact their means are quite close together and there is considerable overlap between the curves.

There should be therefore an increase of the order of 50% in the numbers caught in the 2 in net in June, but the data in Table 6 suggest that there is in fact little significant increase. An equivalent number of fish must therefore have grown beyond the sampling range of this net. To accomplish this, the normally distributed section of the population originally within the range of the 2 in net would have to grow until the curve describing this section intersected hypothetically the curve of action of the net at the 25% mark giving an overlap of 50%. Thus as the intersect at 25% lies at 14.53 cm the mean must move from 13.85 in March to 15.21 in June at which point only 50% of the fish originally available in March will be available in June. If the fish within the 2 in net in March were growing at an average rate of $15.21-13.85=1.36$ cm/2 months then the number of fish growing beyond the action of the 2 in net would equal the number being recruited from $1\frac{3}{4}$ in net.

The rather elaborate procedure above gives growth rates for *T. esculenta* of two different sizes, but because of the several assumptions made in the calculations these can only be regarded as working estimates. From them, however, general estimates of age/length can be made. If the average growth rate of fish under 12.05 cm, the mean of the $1\frac{3}{4}$ in net, is 1.54 cm/2 months, the average growth rate of fish over 13.85 cm, the mean of the 2 in net, is 1.36 cm/2 months, and if for lengths between 12.05 and 13.85 cm the growth rate is the mean of the two estimates, then during the first year the fish would grow 9.25 cm. Similarly at 12.05 cm they would be 15.7 months old, at 13.85 cm they would be 18 months old and at two years they would have grown to 17.8 cm total length. This last figure is almost certainly an over estimate as after 18 months there should be a rapid reduction of the growth rate. It is perhaps reasonable to say that first year growth amounts to 9-10 cm, whilst in the second year a length of 16-18 cm is attained.

From the rise by 63% of numbers in the $2\frac{1}{2}$ in net in June compared with March, a calculation of the increased area of overlap between the 2 in and $2\frac{1}{2}$ in nets, if the mean growth rate of *T. esculenta* in the former is 1.36 cm/2 months, suggests that direct recruitment from the 2 in to the $2\frac{1}{2}$ in net is of the order of 31%. The additional increase observed presumably arises from the poorly sampled area between the two curves, the means not being close together. Growth out of the influence of the $2\frac{1}{2}$ in net must be much slower than recruitment into the range for the large rise in numbers caught to occur.

The general pattern suggested by the above analysis is a peak of numbers passing from the region sampled from the $1\frac{3}{4}$ in net in March into or through the 2 in net sample and impinging upon the $2\frac{1}{2}$ in net by June. Assuming this peak to have resulted from some peak in spawning, then taking the position of the peak in number to approximate the mean of the $1\frac{3}{4}$ in net sample in March, i.e. 12.05 cm, fish of this size were estimated above to be 15.7 months old and were thus spawned in December two calendar years previously. It seems likely therefore that there is a peak of spawning around December; certainly, during March, when seventy-five *T. esculenta* were examined, none were found in anything approaching breeding condition. The smallest mature fish found was 19.0 cm in length. Comparing this figure with the length frequency distribution for all the *T. esculenta* caught in Malya dam, shown in Fig. 1, indicates that only a relatively small segment of the population survives to become mature. Table 5 shows the total number of *T. esculenta* caught in nets of each mesh size, and indicates the markedly smaller numbers caught in the 3 in and larger mesh nets compared with the $2\frac{1}{2}$ in. Both of the above phenomena presumably result directly or indirectly from the use of 3 in nets by the fishermen of the dam.

The length/weight relationship of *T. esculenta* in Malya dam, in terms of the double logarithmic transformation, is given by the regression equation:

$$\log_e \text{Weight} = - 5.055 + 3.37. \log_e \text{Length}$$

DISCUSSION AND CONCLUSIONS

A comparison of the estimates of the growth of *T. esculenta* from Malya dam with those of LOWE-McCONNELL (1956) for this species in Mwanza region of Lake Victoria is shown in Table 8.

Table 8. A comparison of the annual lengths of *T. esculenta* in Malya dam to those of the same species in Lake Victoria (taken from LOWE—McCONNELL 1956).

Age (yrs)	Malya dam	L. Victoria
1	(9–10)cm	15cm
2	(16–18)cm	22cm
3	—	27cm

From this it appears that the growth rate in Malya dam is somewhat slower than in Lake Victoria.

The minimum length at which maturity occurs in the *T. esculenta* of Malya dam is 19.0 cm. By comparison, the minimum length of maturity in Smith Sound, which is at the southern end of Lake Victoria, is 20.5 cm (GARROD 1959) or 23 cm in the open water regions of the Lake in Tanzania (LOWE-McCONNELL 1956). There appears furthermore to be some degree of variation as to the minimum length at which maturity can occur in *T. esculenta* depending upon the locality. The absolute minimum length so far recorded is in the Jinja area where the minimum length is 18.0 cm (GARROD 1959), whereas off the Sesse Islands a value of 26 cm has been recorded (LOWE-McCONNELL 1956). Thus, the minimum length at which maturity occurs in Malya dam lies within the range observed at Lake Victoria, although at the lower end of this range. It is, however, well in advance of the minimum length observed for the same species in the Malya fishponds where the smallest mature fish measured 13.5 cm.

Although the minimum size at maturity of *T. esculenta* in Malya dam is within the range found in Lake Victoria, it is notably lower than the values found in the Lake regions closest to Malya dam as mentioned above. Exactly what factors have produced this difference is impossible to say but one possibility may be the differences in fishing efforts in each locality. FRYEY and ILES (1972), after considering the evidence, have suggested the possible existence of a homeostatis mechanism operating in *T. esculenta* whereby maturity at a smaller size occurs in response to the effect of increased fishing effort removing more of the population. Whatever the reasons for the above differences, however, without maturity occurring at a smaller size than in the southern regions of the Lake, it is unlikely that the dam population would be able to maintain itself bearing in mind that minimum length at which maturity occurs in the dam is 19.0 cm and that the mean length of *T. esculenta* caught in the 3 in mesh nets used by the fishermen in 19.3 cm (Table 7).

It seems likely that there is a peak of spawning for *T. esculenta* in Malya dam, which occurs around December. This agrees with the observation of LOWE-McCONNELL (1956) of a peak in spawning around January in Southern Lake Victoria, coinciding, as in the dam, with the peak of the rainy season. There is no evidence of the persistent spawning activity shown by *T. esculenta* in nearby fishponds (PAYNE 1971).

One feature apparent in Table 5 is the reduction in catch per unit effort from March to July. This phenomenon can also be seen in the accumulated records of the Regional Fisheries Office, Mwanza, with respect to the southern end of Lake Victoria during the same period annually. A possible explanation would arise if during this hot dry period of the year the fishes showed reduced activity, as the effectiveness of gill nets largely depends upon fish coming into contact with the net. In Lake Victoria the fish may migrate to some inaccessible place but this was not possible in the dam as all parts could be sampled by the nets.

On the whole, the biological pattern of *T. esculenta* in Malya dam is similar to that shown by this species in Lake Victoria. It does not resemble the pattern shown by *Tilapia* in fishponds, i.e. spawning persistently and at very small sizes. This is presumably as a result of the lack of crowding in the dam or the greater ecological diversity of the dam environment.

As to a general policy for stocking dams, the data presented in the first section above show that, despite extensive attempts to stock Malya dam with several species of *Tilapia,* the effect compared with the contribution by local cichlids and non-cichlids is marginal. It is notable that the most economically important species, *T. esculenta,* is endemic to the area. This possibility arises, therefore, that stocking new waters in any part of Africa with one of a few well-known species of *Tilapia* is not the best policy, but that stocking with local relatively unknown species may give unforseen advantages.

In Malya dam, *T. esculenta* is overwhelmingly dominant compared with *T. macrochir,* the other planktivore, and, despite intensive efforts, *T. zillii* could not be established probably because the herbivorous *T. rendalli* was already there. Multiple stocking of *Tilapia* species does not seem to have been of much benefit. Perhaps more attention shonld be paid to the biological properties of non-cichlids in this respect.

The usefulness of stocking with *Tilapia* species relying largely upon macrophytes for food is problematical. In Malya dam they are relatively unimportant but become more important in the smaller dams investigated (Table 4). This could be a result of their methods of feeding and reproduction which tend to restrict them to the dam periphery, which will become progressively less important as a habitat with increase in dam size. Thus, in Malya, the largest dam, stocking with herbivorous *Tilapia* was of little real value.

SUMMARY

A survey of the fishes of Malya dam was carried out over a five-month period from March to July.

Ten species of fish were found in the dam

at least seven and probably eight of which must have colonised the water naturally.

The characteristics of fish necessary to come to terms with the dam environment are discussed.

Three *Tilapia* species have been recorded as being stocked artificially in the dam, *T. macrochir*, *T. rendalli* and *T. zillii*. Of these the first two species have established themselves although they are not particularly abundant. *T. zillii* has failed completely to establish itself, most probably owing to competition with *T. rendalli* which had been introduced first.

T. esculenta is the most economically important species in the dam. It grows more slowly and matures at a smaller size than fish of the same species in the southern end of Lake Victoria. Its reproductive pattern is much closer to that shown by *T. esculenta* of the Lake rather than those of nearby fishponds.

REFERENCES

Bailey, R. (1966). The dam fisheries of Tanzania. *E. Afr. agric. J. 32 (1):* 1-15.

Corbet, P. S. (1961). The food of non-cichlid fishes in the Lake Victoria basin, with remarks on their evolution and adaptation to lacustrine conditions. *Proc. Zool. Soc. Lond. 136 (1):* 1-101.

Fish, G. R. (1955). The food of *Tilapia* in East Africa. *Uganda Journal 19 (1):* 85-89.

Fryer, G., and Iles. T. D. (1972). The cichlid fishes of the great lakes of Africa. Oliver and Bayd, Edinburgh. 641 p.

Garrod, D. J. (1959). The growth of *Tilapia esculenta* Graham in Lake Victoria. *Hydrobiologia 12 (4):* 268-298.

Garrod, D. J. (1961). The selection characteristics of nylon gill nets for *Tilapia esculenta* Graham. *J. Conseil. Explor. Mer 26 (2):* 191-203.

Golterman. H. L. (1969). Chemical analysis of fresh waters. *IBP Handbook* No. 8. Blackwell. Oxford. 172 p.

Gosse. J. P. (1963). Le milieu aquatique et l'écologie des poissons dans la région de Yangambi. *Annls. Mus. r. Afr. cent. 8vo 116.* 249 p.

Kiener, A., and Lamarque. P. (1969). A short note on the rearing of *Tilapia* in a particular environment in the south-west of France. *Verhandl. Int. Ver. Limnol. 17 (4):* 662-664.

Lowe-McConnell, R. H. (1956). Some observations on the biology of *Tilapia esculenta* Graham (Pisces, Cichlidae) in Lake Victoria. *E. Afri. Freshwat. Fish. Res. Org. Suppl. Publ.* No. 1. 1-72.

Lowe-McConnell, R. H. (1959). Breeding behaviour patterns and ecological differences between *Tilapia* species and their significance for evolution within the genus *Tilapia* (Pisces. Cichlidae). *Proc. Zool. Soc. Lond. 132 (1):* 1-30.

Lowe-McConnell, R. H. (1969). Speciation in tropical freshwater fishes. *Biological J. Linn. Soc. 1:* 51-75.

Margalef. R. (1959). Mode of evolution of species in relation to their places in ecological succession. *Proc. 15th. Int. Congr. Zool.,* 787-789.

Payne, A. I. (1971). An experiment on the culture of *Tilapia esculenta* Graham and *Tilapia zillii* (Gervais) (Cichlidae) in fishponds. *J. Fish. Biol. 3 (3):* 325-340.

Thys van den Audenaerd, D. F. E. (1964). Révision systematique des espèces congolaises du genre *Tilapia* (Pisees, Cichlidae). *Annls. Mus. r. Afr. centr. 8vo 124,* see p. 34.

Trewavas, E. (1973). On the cichlid fishes of the genus *Pelmatochromis* with proposal of a new genus for *P. congicus;* on the relationship between *Pelmatochromis* and *Tilapia* and the recognition of *Sarotherodon* as a distinct genus. *Bull. Br. Mus. nat. Hist (Zool.) 25 (1).* 1-26.

Whitehead. P. J. P. (1959). The anadromous fishes of Lake Victoria. *Rev. Zool. Bot. afr. 59 (3):* 329-361.